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FREE-AIR BLAST EVALUATION
OF RDX/TNT/ALUMINUM
IN VARIOUS PROPORTIONS

Contract DAI-19-020-501-ORD-(P)-58

FOURTH QUARTERLY REPORT

NN-Q-4

January, February, March 1956

Copy No. 06

NATIONAL NORTHERN

West Hanover, Massachusetts

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The Technical Division of National Fireworks Ordnance Corp.

1.0 INTRODUCTION

This is a quarterly report of testing accomplished during the period January through March 1956 for Picatinny Arsenal under Contract No. DAI-19-020-501-ORD-(P)-58, and is designated as NN-Q-4. The first, second, and third quarterly reports were designated as NN-Q-1, NN-Q-2, and NN-Q-3. A final report which will summarize and evaluate all four quarterly reports will be submitted in the near future.

2.0 OBJECT OF TEST

These tests were conducted to determine Free-Air blast of experimental samples consisting of RDX/TNT/Aluminum in various proportions, weighing approximately one pound each. The test samples were spherical in shape and uncased. Fourteen (14) compositions were tested in this phase.

3.0 CHARGE DATA

3.1 This report details the test data and results of the fourth group of HE charges shipped to National for test. This fourth group consisted of one hundred and forty rounds, or fourteen series of ten rounds each. One of the fourteen series was TNT which was used as a control sample. The remaining thirteen series were new compositions.

3.2 The spherical charge data are as follows:

Shape: Spherical, 3 1/4" diameter, and cast in mold described by Drwg. No. SK 43375.

Booster: 1" x 1" tetryl pellet having a 0.315 diameter central cavity. This pellet was located in the center of the cast spherical charge.

Initiator: A No. 8 electric blasting cap was used to initiate the tetryl booster on each except 5 of the TNT and 5 of the HBX-1 charges (code A and X-1) where U. S. Special Engineers electric blasting caps were used to determine whether the No. 8 blasting cap was marginal for high order initiation.

3.3 The composition and weight data supplied by Picatinny Arsenal:

<u>No. Charges</u>	<u>HE Code</u>	<u>% RDX</u>	<u>% TNT</u>	<u>% Al</u>	<u>D-2 Wax</u>	<u>Average Wt. (grams)</u>	<u>*Average Density</u>
10	A	---	100	---	--	460	1.58
10	BBB	61	29	10	--	503	1.72
10	CCC	52	28	20	--	528	1.81
10	DD	47.5	27.5	25	--	540	1.85
10	EE	43	27	30	--	550	1.88
10	FF	34	26	40	--	561	1.92
10	II	66	24	10	--	605	1.73
10	JJ	56.5	23.5	20	--	529	1.81
10	KK	52	23	25	--	542	1.86
10	LL	47.5	22.5	30	--	529	1.81
10	MM	38	22	40	--	552	1.89
10	**X-1	40	38	17	5	494	1.69
10	**X-3	31	29	35	5	528	1.81
10	**X-6	45	30	20	5	500	1.71

*Computed by National using a 292 cc volume.

**Noted by Picatinny as standard HBX-1, HBX-3, and HBX-6 for X-1, X-3, and X-6 respectively. In addition these 3 items have 0.5% of CaCl₂ added.

3.4 Ten (10) spherical TNT charges remain on hand at National. These will be used for control samples on future firings.

4.0 TEST EQUIPMENT

The static blast tests of the subject charges were conducted at National's Halifax Range at the Free-Air Blast Site. This site consists of a quad - instrument arrangement for detecting blast from a single charge. Details of this site and the Semi-Confined Blast Site (used to evaluate HE blast having partial confinement) are reported in National's Report NN-P-30 of July 1955 entitled "Blast Evaluation of Bare and Cased High Explosives". The details and instrumentation of the Free-Air Blast Site are briefly as follows:

4.1 Charge. The charge is placed 9 ft. above ground level. The axis of a cylindrical charge or projectile is always placed at 45° from the vertical and horizontal plane. In these tests, with the charges being spherical, the cap cavity was

placed facing up in the vertical plane.

4.2 Gauges. Four detectors are located, each in different quadrants, around the charge and at various distances from it. Each instrument is placed to receive the free-air blast (incident) wave, i.e., no reinforcement from reflected or Mach waves. These four detectors are as follows:

4.2.1 Pendulum Gauge. Designed by National to record an integration of pressure-time. It is 290 lbs. in weight, and 2 ft. square. The charge center is located 3 ft. from it.

4.2.2 Catenary Diaphragm. Developed for use in the determination of high-explosive blast to record pressure-time, side-on to the blast wave and 6' 8" from the charge's center.

4.2.3 Foilmeter. National's modification of the Bikini Gauge used to record peak pressure, face-on to the blast front at 5 feet from the charge's center. Foil is '0025-S aluminum.

4.2.4 5" N-T-C. Designed by National as a possible means for correlating with aircraft damage beyond an over-kill area. The gauge is 5" in diameter, facing the charge, and has steel tubular compartments (T-C) 6" in length with '0025-S aluminum foil between compartments. The face of No. 1 compartment is 6 ft. from the charge's center.

5.0 TEST RESULTS

5.1 Detailed recordings of the individual charges are listed in the enclosed Tables I - IV inclusive, and are summarized as follows:

Free-Air Blast, 1 lb. Bare Spherical Charges
High Explosive Composition

<u>HE Code</u>	<u>% RDX</u>	<u>% TNT</u>	<u>% Al</u>	<u>% D-2 Wax</u>	<u>% CaCl₂ Added</u>
A	--	100	--	--	--
BBB	61	29	10	--	--
CCC	52	28	20	--	--
DD	47.5	27.5	25	--	--
EE	43	27	30	--	--
FF	34	26	40	--	--
II	66	24	10	--	--
JJ	56.5	23.5	20	--	--
KK	52	23	25	--	--
LL	47.5	22.5	30	--	--
MM	38	22	40	--	--
X-1	40	38	17	5	0.5
X-3	31	29	35	5	0.5
X-6	45	30	20	5	0.5

Free-Air Blast Readings, Averages

<u>HE Code</u>	<u>Pendulum (degrees)</u>	<u>Follmeter</u>	<u>5"N-T-C</u>	<u>Catenary Δ psi</u>
A	16.6	8.0	4.9	22.1
BBB	19.9	9.1	6.2	25.1
CCC	21.7	9.1	7.2	25.6
DD	21.9	9.4	7.2	25.9
EE	22.1	9.3	7.0	25.6
FF	21.0	9.3	7.2	25.8
II	20.0	9.1	6.4	24.4
JJ	21.9	9.4	6.8	25.7
KK	21.3	9.9	6.9	25.7
LL	20.9	9.8	7.0	25.3
MM	21.0	9.3	6.9	25.2
X-1	19.6	9.1	6.5	24.7
X-3	20.6	9.2	6.7	25.5
X-6	19.8	9.4	6.7	25.4

The above tables of averages are for the following number of rounds:

<u>HE Code</u>	<u>Pendulum</u>	<u>Follmeter</u>	<u>5"N-T-C</u>	<u>Catenary</u>
A	10	10	10	9
BBB	10	10	10	9
CCC	10	10	10	9
DD	10	10	10	8
EE	9	10	10	9

<u>HE Code</u>	<u>Pendulum</u>	<u>Foilmeter</u>	<u>5"N-T-C</u>	<u>Catenary</u>
FF	9	10	10	8
II	9	9	9	5
JJ	10	10	10	9
KK	10	10	10	9
LL	10	10	10	9
MM	10	10	10	9
X-1	10	10	10	9
X-3	10	10	10	9
X-6	10	10	10	9

5.2 The average data for the items using both the No. 8 and the USA Special Engineers electric blasting caps are listed for comparison:

<u>HE Code</u>	<u>No. Rds.</u>	<u>Initiator</u>	<u>Free-Air Blast Readings (Averages)</u>			
			<u>Pendulum</u>	<u>Foilmeter</u>	<u>5"N-T-C</u>	<u>Catenary</u>
A	10	No. 8	16.1	7.5	4.7	23.1
A	10	No. 8	15.8	8.1	4.8	21.5
A	10	No. 8	16.8	8.0	4.6	20.4
A	5	No. 8	16.8	8.0	5.4	22.0
A	5	USA	16.4	8.0	4.4	22.2
X-1	5	No. 8	19.5	9.4	6.6	24.7
X-1	5	USA	19.7	8.8	6.4	24.6

The first 3 lines of HE code A listed above were taken from the three quarterly reports NN-Q-1, NN-Q-2, and NN-Q-4 respectively. Code A is TNT and code X-1 is HBX-1.

6.0 CONCLUSIONS

6.1 The results of the Free-Air blast performance tests on the RDX/TNT/

Al compositions indicate that:

(1) A 50% RDX, 25 - 30% TNT, and 20 - 25% Al composition is the best free-air blast producer. This confirms the conclusion made in NN-Q-3.

(2) Code DD composition was the best performer in the fourth series reported herein. It had the highest blast readings in 2 of the 4 monitors. Its composition is 47.5/27.5/25 RDX/TNT/Al.

(3) The addition of D-2 wax to compositions detracted from its blast performance.

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6.2 The No. 8 electric blasting cap provided sufficient energy for high order detonations of the booster pellets used in these tests.

7.0 WORK STATUS

7.1 This report is the fourth quarterly report.

7.2 One hundred and forty (140) rounds were fired during this fourth quarter (511man-hours).

Note: The man-hour figure is through March 1956.

7.3 Ten (10) rounds of spherical TNT remain on hand at National.

7.4 A summary report of the four quarterly reports will be issued about one month after the release of this report.

8.0 DETAILED TEST DATA

8.1 Table I. Free-Air Pendulum

<u>HE</u> <u>Code</u>	<u>Rd:</u>	<u>Pendulum Readings</u>										<u>Average</u>
		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	
A		18	17.5	16	16.5	16	17	16	16.5	16.5	16	16.6
BBB		22	21	18.5	21	19.5	20	19.5	18	20	19.5	19.9
CCC		22	22	21	20.5	21.5	22	22	21.5	21.5	22.5	21.7
DD		22	22.5	21	20.5	21.5	23	22.5	22	21.5	22	21.9
EE		24	--	19.5	22	23	23	22.5	21.5	22	21	22.1
FF		21	--	21	20.5	20.5	21.5	22	21	21.5	20	21.0
II		20	20	19	20	20	--	20.5	20	20	20.5	20.0
JJ		24	21	21	22.5	20.5	22	23	22	21.5	21	21.9
KK		23	19	21	20	20.5	22.5	20	23.5	22.5	21	21.3
LL		22.5	21	20.5	20	20	21.5	21	21.5	20.5	20.5	20.9
MM		23	19	20.5	20.5	21	22.5	21.5	20	21	21	21.0
X-1		22.5	18	18.5	19	19.5	20.5	19.5	19	20	19.5	19.6
X-3		23	20	20.5	20	19.5	21.5	21	21	19.5	20	20.6
X-6		21	18	20	20	20	21	20	18.5	20	19	19.8

Note: Rds. 6 - 10 on code A and X-1 had U. S. A. Special Engineers blasting caps. All others had No. 8 electric.

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8.2 Table II. Follmeter

<u>HE</u> <u>Code</u>	<u>Rd:</u>	<u>Follmeter Readings</u>										<u>Average</u>
		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	
A		8	8	8	8	8	8	8	8	8	8	8.0
BBB		9	9	8	9	9	9	10	9	9	10	9.1
CCC		10	8	9	9	9	9	9	9	9	10	9.1
DD		10	8	10	9	10	9	10	9	9	10	9.4
EE		10	9	9	9	8	9	10	9	10	10	9.3
FF		9	9	9	10	9	9	9	10	9	10	9.3
H		9	9	9	9	10	--	9	9	9	9	9.1
JJ		9	10	10	8	10	10	9	9	10	9	9.4
KK		10	10	9	10	10	10	10	10	10	10	9.9
LL		10	10	10	9	10	10	10	9	10	10	9.8
MM		9	9	10	10	9	9	10	8	10	9	9.3
X-1		9	9	10	9	10	8	9	9	8	10	9.1
X-3		9	9	9	9	8	10	10	10	9	9	9.2
X-6		9	9	9	9	10	10	10	9	9	10	9.4

Note: Rds. 6 - 10 on code A and X-1 had USA Special Engineers blasting caps. All others had No. 8 electric.

8.3 Table III. 5" N-T-C

<u>HE</u> <u>Code</u>	<u>Rd:</u>	<u>5" N-T-C Readings</u>										<u>Average</u>
		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	
A		6	5	5	4	7	6	5	4	3	4	4.9
BBB		5	6	6	7	6	6	6	6	7	7	6.2
CCC		6	5	7	9	10	8	6	6	7	8	7.2
DD		7	7	7	7	8	8	6	7	8	7	7.2
EE		7	7	8	7	6	7	6	8	7	7	7.0
FF		6	7	7	9	6	7	6	9	8	7	7.2
H		6	7	6	7	7	--	8	6	5	6	6.4
JJ		7	6	7	7	7	8	7	5	7	7	6.8
KK		6	7	7	8	7	6	7	8	6	7	6.9
LL		8	8	8	8	6	7	6	6	8	7	7.0
MM		8	7	7	7	8	7	7	8	6	6	6.9
X-1		6	7	6	7	7	7	7	7	5	8	6.5
X-3		7	8	6	7	6	7	7	6	6	7	6.7
X-6		6	8	7	7	7	7	7	7	7	6	6.7

Note: Rounds 6 - 10 on code A and X-1 had USA Special Engineers blasting caps. All others had No. 8 electric.

8.4 Table IV. Catenary Diaphragm

<u>HE</u> <u>Code</u>	<u>Rd:</u>	<u>Catenary Readings (Δ psi)</u>										<u>Average</u>
		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	
A		--	22	22	22	22	21	22	22	24	22	22.1
BBB		--	26	25	26	25	24	25	24	27	24	25.1
CCC		--	24	24	26	25	25	26	26	26	26	25.6
DD		--	--	26	26	26	25	25	26	27	26	25.9
EE		24	--	26	25	26	25	26	26	26	26	25.6
FF		--	--	26	25	25	27	26	26	26	25	25.8
II		24	24	--	--	24	25	--	25	--	--	24.4
JJ		--	27	27	26	25	27	25	25	25	25	25.7
KK		--	26	26	24	24	27	25	27	26	27	25.7
LL		--	26	26	25	25	26	26	25	25	25	25.3
MM		--	26	26	25	25	27	25	24	24	25	25.2
X-1		--	24	27	24	24	26	24	23	25	25	24.7
X-3		--	25	20	24	24	26	25	24	27	28	25.5
X-6		--	25	26	24	24	27	26	26	25	25	25.4

Note: Rds. 6 - 10 on code A and X-1 had USA Special Engineers blasting caps.
All others had No. 8 electric.

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